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Armed Services Technical Information Agency

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ATTACHMENT

U. S. Army Prosthetics Research Laboratory
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Washington 25, D. C.

144-145
12/22

POSSIBLE EPOXY LAMINATE ANALYSIS

James T. KELL
Pvt., William C. Wadsworth

FC
BAC

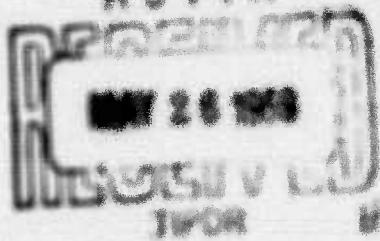
Approved by:

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Fire Director

Part VII, Effect of Curing Time on Laminate Properties

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III. DATA

I. III

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The 100° and 70° series plotted in Fig. 1 and listed in Table II. It may be noted that highest effective porosities were obtained at 70°C. The results of the 100° series are given in Table III. The physical properties of the laminates will be discussed.

Samples A and C (70° cure) were the only two laminates in this series which had enough data to reach any definite conclusions concerning the effect of curing time on their properties. However, there is an indication that a curing time of 1 hour or 2 hours may be obtained by curing between 1 and 3 hours, the 1 hour being best. The 70°C series will be completed in the future.

Sample F (100 minute cure) in the 80°C series shows the best compressive strength. It is interesting to note that this sample also was cured for 2 hours, while all the standard laminates have been cured under conditions of 1 hour. Sample F is one of all the samples tested, this one had the highest compressive strength. However, in the 100° series, the 1 hour sample shows more favorable compressive properties. This is probably due to the higher curing temperature; the 2 hours being too long at such a high temperature.

DISCUSSION

With the 70° series, due to incomplete results, no definite conclusion can be derived. However, generally it can be stated that the best results should be obtained between 1½ and 2 hours.

In the 80° series the 1 hour cure appears to have more favorable physical properties, but since the effective porosity is only half that of the 2 hour cure, the 2 hour cure may be considered the most desirable. In the 100°C series the 1 hour cure proved to give the best result.

NOTES

A (70° x 60 minutes) and C (100° x 30 minutes) gave similar impact strengths although they are at the extremes of porosities, sample A having a porosity of 40% and sample C with 13%. Both of these samples showed the lowest impact strengths. Previous experiments have shown that the laminates with intermediate porosities give higher impact resistances. This trend was observed in this series.

Sample	T ₁	T ₂
A	70	
B*	70	
C	70	
D*	70	
E	80	
F	80	
G	80	
H*	80	
I	100	
J	100	
K	100	
L	100	

*Samples B, D and H were discarded.

At high porosities, the laminate is so resilient that it collapses under a relatively light load. On the other hand, a laminate will become more susceptible to an earlier craze or crack when the effective porosity is low.

IV. CONCLUSIONS

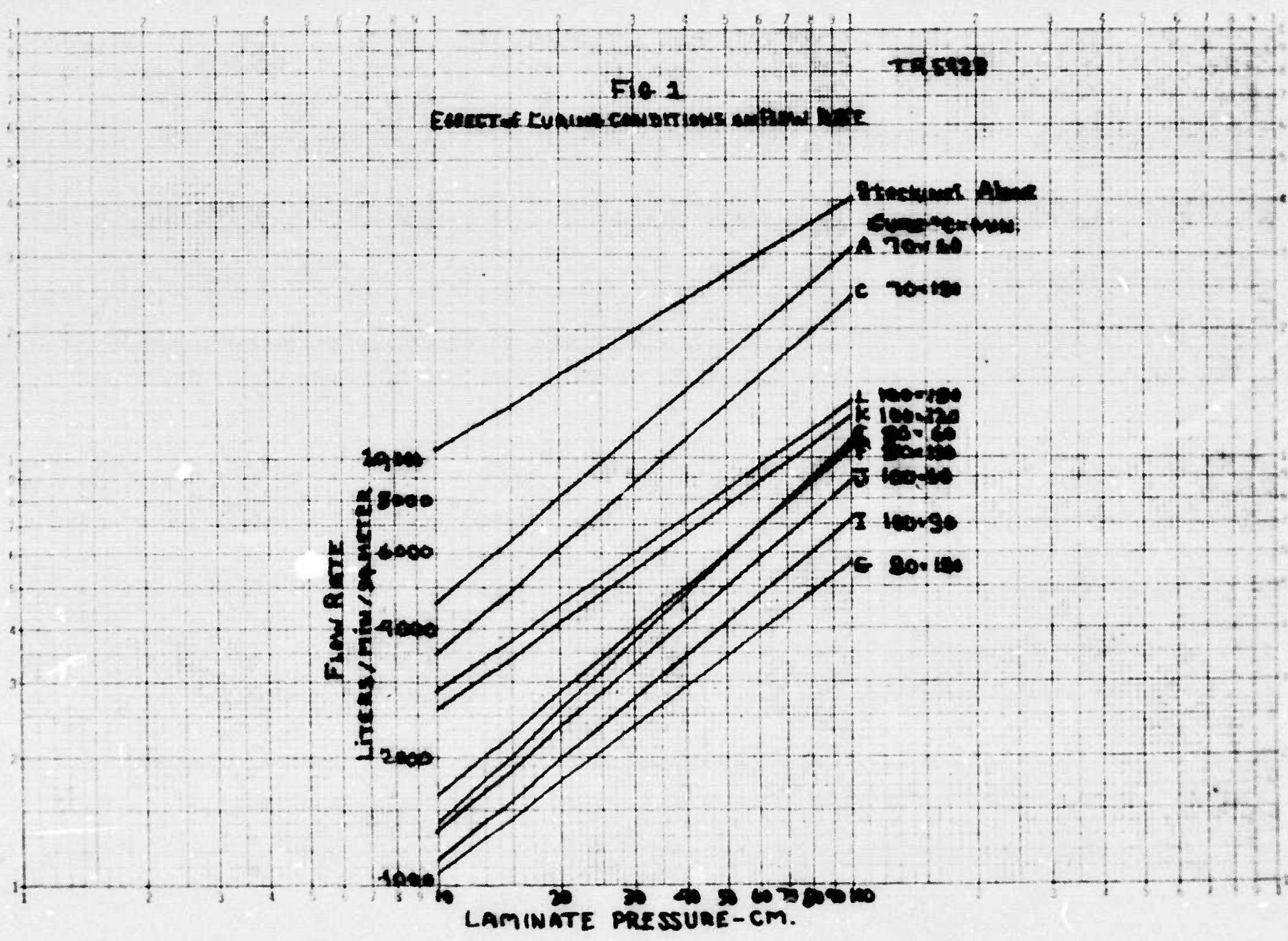
1. The compressive stress at buckle of the laminate is not significantly affected by curing temperature or curing times over the range tested. Therefore, the effective porosity should be the controlling factor to be considered when choosing curing conditions with respect to compressive properties.
2. The bearing stress at 4% elongation, like compressive stress, does not appear to be significantly affected by curing conditions over the range tested. Again, the effective porosity appears to be the controlling factor.
3. The impact resistance like bearing and compressive strength is controlled by effective porosity rather than curing conditions over the range tested. As a result of these tests we make a general conclusion that the laminates may be completely cured at a temperature of 70°C or higher after a minimum precurse of 60 minutes. The best conditions for curing, taking into effect effect porosity and physical properties, appear to be 70°C for 120 minutes. Longer or higher temperatures tend to cause discoloration of the laminates.

V. RECOMMENDATION

1. An addendum to the Link Shop procedure (T.R. #5840) for fabrication of porous laminates must be prepared. This addendum should contain a recommendation stating the use of a 70°C cure instead of the 80°C cure now in use.

TABLE II

Spec.	Cure Temp (°C)	Cure Time (min.)	COMPRESSION		TENSILE		IMPACT		Effective Porosity (%)
			Stress at Buckle (psi)	Strain (in/in)	Modulus, Ult. Stress (psi)	Stress (psi)	Initial Crack (in. lbs)	Impact Energy (in. lbs)	
A	70	60	334	.0109	1011	10,366	12	15	60.4
C	70	180	804	.013	1133	4,666	18	21	46.2
E	80	60	512	.006	1665	6,033	15	13	20.3
F	80	120	1457	.015	2153	8,230	15	21	21.2
G	80	180	1262	.013	3530	10,800	15	13	12.4
I	100	30	753	.009	2519	7,244	12	15	12.3
J	100	60	662	.004	2461	5,076	18	21	17.7
K	100	120	515	.023	2300	5,630	15	21	20.4
L	100	180	737	.0109	1111	5,105	15	13	30.4



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